NASA Conference Publication 10189

HBCUs Research Conference Agenda and Abstracts

Proceedings of a conference held at
Ohio Aerospace Institute
Cleveland, Ohio
April 10–11, 1996

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Proceedings of the Conference
held at the
Ohio Aerospace Institute
Cleveland, Ohio
sponsored by NASA Lewis Research Center
Cleveland, Ohio
April 10–11, 1996

National Aeronautics and
Space Administration

Office of Management

**Scientific and Technical
Information Program**

1996

LeRC HBCUs CONFERENCE

HBCUs RESEARCH CONFERENCE

APRIL 10–11, 1996

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National Aeronautics and
Space Administration

Lewis Research Center
Cleveland, OH 44135-3191

Reply to Attn of:

NASA Lewis Research Center's commitment to excellence continues to grow in terms of investment and support for Historically Black Colleges and Universities (HBCUs). Over the last 3 years, Lewis' total research and development grant awards to 16 HBCUs exceeded its performance goal by a substantial margin.

Lewis' HBCUs Research Program is designed to utilize the ability of HBCUs to conduct fundamental science and develop physical infrastructure related to NASA's disciplines. To reach our goals, we must build partnerships with other Government agencies, industry, and academia. Our research partnerships with the Nation's HBCUs are an integral part of our strategy.

The HBCUs Research Conference is a critical element in ensuring the success of Lewis research programs. In addition, it provides a forum for showcasing the research capabilities of the participating HBCUs.

It is with great pleasure that I welcome the participants and congratulate everyone associated with the Third NASA HBCUs Research Conference.

Donald J. Campbell
Director

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Reply to Attn of:

This Research Conference is the third one at which researchers and students from Historically Black Colleges and Universities (HBCUs) present progress reports on Lewis-sponsored research. Lewis management and researchers are proud of the results obtained to date and encouraged by the competence and contributions of the Principal Investigators (PIs) and student researchers.

I welcome all presenters and congratulate you for the comprehensive quality of topics covered by your research programs. Also, I congratulate and thank the Lewis Technical Monitors for their excellent support. The phrase "Lewis means teamwork" is directly applicable to the partnerships between Lewis and HBCUs.

Julian M. Earls
Deputy Director for Operations

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HBCUs RESEARCH CONFERENCE
April 10–11, 1996

AGENDA

Presiding: Dr. Sunil Dutta
SDB Program Manager

Wednesday, April 10, 1996

8:30–9:20 a.m.	Introduction
Introduction and Welcome:	**Dr. Julian Earls** Deputy Director for Operations NASA Lewis Research Center **Dr. Michael J. Salkind** President Ohio Aerospace Institute
Welcome and Center Overview:	**Mr. Donald J. Campbell** Director NASA Lewis Research Center
9:20–10:20 a.m.	Oral Presentation Three (3) Concurrent/Parallel Sessions
10:20–10:40 a.m.	Break
10:40–12 noon	Oral Presentation Three (3) Concurrent/Parallel Sessions
12 noon–1:00 p.m.	Lunch
1:00–2:20 p.m.	Oral Presentation Three (3) Concurrent/Parallel Sessions
2:20–2:40 p.m.	Break
2:40–4:40 p.m.	Poster Sessions

Thursday, April 11, 1996

9:00–12 noon	Individual Principal Investigator/Technical Monitor Meetings
12 noon–1:00 p.m.	Lunch
1:00–3:00 p.m.	Remove Poster Presentations

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HBCU Research Conference
List of Poster Papers
April 10, 1996

P1	Alabama A&M University	"Waveguides in Thin Film Polymeric Materials"
P2	Alabama A&M University	"Optical Diagnostics of Solution Crystal Growth"
P3	Central State University	"Effects of Variable Gravity on Evaporation of Binary Fluids in a Capillary Pore Evaporator"
P4	Central State University	"Performance Evaluation in Network-based Parallel Computing"
P5	Central State University	"Design, Construction and Testing of Annular Diffusers for High Speed Civil Transportation Combustor Applications"
P6	Central State University	"Research Laboratory for Engineering and Technology (ReLEnT)—Summer Program"
P7	Central State University	"Establishment of a BETA Test Center for the NPARC Code at Central State University"
P8	Clark Atlanta University	"Optimizing Process Parameters to Produce Single Phase $YBa_2Cu_3O_7$Powder"
P9	Clark Atlanta University	"Turbulent Methane-Air Combustion"
P10	Fisk University	"Momentum Transfer Studies and Studies of Linear and Nonlinear Optical Properties of Metal Colloids and Semiconductor Quantum Dots"
P11	Hampton University	"Parallelization of Rocket Engine System Software (Press)"
P12	Howard University	"Expendable Launch Vehicle Studies"
P13	Howard University	"Determination of Thermal State of Charge in Solar Heat Receivers"
P14	Howard University	"Flame Characterization Using a Tunable Solid-State Laser With Direct UV Pumping"
P15	Howard University	"Epitaxial Growth of β-Silicon Carbide (SiC) on a Compliant Substrate via Chemical Vapor Deposition (CVD)"
P16	Howard University	"Application of Hybrid Optimization-Expert System for Optimal Power Management on Board Space Power Station"
P17	Howard University	"Advanced Intelligent System Application to Load Forecasting and Control for Hybrid Electric Bus"
P18	Howard University	"Howard University Energy Expert Systems Institute Summer Program (EESI)"
P19	Howard University	"Solar Dynamic Power System Fault Diagnosis"

P20	Howard University	"Fault Diagnosis of Power Systems Using Intelligent Systems"
P21	Howard University	"Design of Power System Architectures for Small Spacecraft Systems"
P22	Howard University	"Solar Dynamic Power System Stability Analysis and Control"
P23	Howard University	"On-line Tracking Controller for Brushless DC Motor Drives Using Artificial Neural Networks"
P24	Johnson C. Smith University	"The Conservation/Solution Element (STE) Method for Linear Potential Flow Problems"
P25	Norfolk State University	"An NMR Study of Microvoids in Polymers"
P26	N. Carolina A&T State U.	"Experiments Related to the Fabrication of Carbon Fiber/AMB-21 Polyimide Composite Tubes Using the RTM Process"
P27	N. Carolina A&T State U.	"Graphite Fiber Textile Preform/Copper Matrix Composites"
P28	Prairie View A&M	"A CFD Study of Turbojet and Single-Throat Ramjet Ejector Interaction"
P29	Savannah State College	"A Cost Comparison of Alternative Approaches to Distance Education in Developing Countries"
P30	Southern University	"Knowledge Engineering for Preservation and Future Use of Institutional Knowledge"
P31	Tennessee State University	"Implementation of Probabilistic Design Methodology at Tennessee State University"
P32	Tennessee State University	"Robust Integrated Neurocontroller for Complex Dynamic Systems"
P33	Tuskegee University	"Sputtering Erosion in Ion and Plasma Thrusters"
P34	Wilberforce University	"Research Institute for Technical Careers"
P35	Clark Atlanta University	"Nonstandard Finite Difference Schemes: Relations Between Time and Space Step-Sizes in Numerical Schemes for PDE's That Follow From Positivity Condition"
P36	North Carolina A&T State University	"Numerical Simulations of Wing-Body Junction Flows"

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Waveguides in Thin Film Polymeric Materials

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ABSTRACT

Results on the fabrication of integrated optical components in polymeric materials using photo printing methods will be presented. Materials selected for light guiding films include: Photosensitive polyimide Ultradel 9020D, and poly(methyl methacrylate) (PMMA) doped with organic laser dyes 4-dicyanomethylene-2-6-p-dimenthylaminostyryl-4h-pyran (DCM) and 1,3,5,7,8 - pentamethyl-2, 6 - diethyl-pyrromethene -BF_2 complex (Pyrromethen 567, PM-567). Optical waveguides were fabricated by spin coating preoxidized silicon wafers with organic dye/polymer solution followed by soft baking. The waveguide modes were studied using prism coupling technique. Propagation losses were measured by collecting light scattered from the trace of a propagation mode by either scanning photodetector or CCD camera. We observed the formation of graded index waveguides in photosensitive polyimides after exposure of UV light from a mercury arc lamp. These photosensitive polyimides are photocrosslinked after exposure energies below .003 J/cm^2. We observed the development of graded index waveguides after curing the photosensitive polyimide at energies above 60 J/cm^2. By using a theoretical model, an index profile was reconstructed which is in agreement with the profile reconstructed by the Wentzel-Kramers-Brillouin calculation technique using a modal spectrum of the waveguides. Proposed mechanism for the formation of the graded index includes photocrosslinking followed by UV curing accompanied with optical absorption increase. We also developed the prototype of a novel single-arm double-mode interferometric sensor based on our waveguides. It demonstrates high sensitivity to the change of ambient temperature (2π phase shift per 2°C). The device can find possible applications in aeropropulsion control systems.

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Optical Diagnostics of Solution Crystal Growth

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ABSTRACT

Non-contact optical techniques such as, optical heterodyne, ellipsometry and interferometry, for real time in-situ monitoring of solution crystal growth are demonstrated. Optical heterodyne technique has the capability of measuring the growth rate as small as 1Å/sec. In a typical Michelson interferometer set up, the crystal is illuminated by a Zeeman laser with frequency ω_1 and the reference beam with frequency ω_2. The reflected beam detector output has a dc component plus an rf signal at the beat frequency $(\omega_1-\omega_2)$. As the crystal grows, the phase of the rf signal changes with respect to the reference beam and this phase change is related to the crystal growth rate. This technique is demonstrated with two examples: (1) by measuring the copper tip expansion/shrinkage rate and (2) by measuring the crystal growth rate of L-arginine phosphate (LAP). The first test shows that the expansion/shrinkage rate of copper tip (54.9 to 39.1Å/sec) was fast in the beginning, and gets slower as the expansion begins to stabilize with time. In crystal growth, the phase change due the crystal growth is measured using a phase meter and a strip chart recorder. A phase change of 2π corresponds to an optical path change of 3164Å, and by knowing the chart recorder speed, the growth rate can be calculated. Our experimental results indicate a varied growth rate from 69.4 to 92.6Å per sec. The ellipsometer is used to study the crystal growth interface. Generally the ellipsometer measures the ellipsometric parameters Ψ and Δ. From these measurements and a theoretical modeling of the interface, the various optical parameters can be deduced. Interferometry can also be used to measure the growth rate and concentration gradient in the vicinity of the crystal.

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Effects of Variable Gravity on Evaporation of Binary Fluids in a Capillary Pore Evaporator

034815
IP.

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ABSTRACT

The research project, in its third phase, focuses on experimental investigation of the capillary-pumped evaporative heat transfer phenomenon. The objective is to examine whether the heat transfer and stability of a heated meniscus in a capillary pore can be enhanced by adding trace amounts of a non-volatile solute to a solvent and to understand the changes that occur. The experimental setup consists of a single pore evaporator connected to a reservoir which supplies liquid to the evaporator. Experiments were conducted for 0.25W increments at tube inclinations of 15, 45, and 90 degrees. For each of these configurations, binary fluid mixtures composed of 100% pentane, 98.5% pentane, and 97% pentane (by weight) were considered. In addition to the experiments of capillary-pumped evaporation, a parallel experimental study has been conducted to systematically investigate the effects of gravity as well as the effects of bulk composition on the heat transfer characteristics of evaporating binary thin films near the contact line region along an inclined heated surface. To investigate the buoyancy effects on evaporation along an inclined heated surface, the angle of inclination from a horizontal plane was varied fro 15° to 90°. An optimum concentration between 0.5% and 1% decane in pentane/decane solutions has been demonstrated at different angles of inclination. Improved heat transfer was found for the geometry with the smallest angle of inclination of 15 degrees. In addition, flow visualization has revealed that at low inclination angles effective heat transfer takes place primarily due to an extension of the thin film near the contact line. At these low inclination angles, the optimum concentration is associated with enhanced wetting characteristics and reduced thermocapillary stresses along the interface. Such results have relevance to the development of binary fluid capillary-pumped phase change devices for use both in 1-g and 0-g environments. Construction of μ-g experiments to confirm these findings is in progress.

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Performance Evaluation in Network-based Parallel Computing

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ABSTRACT

Network-based parallel computing is emerging as a cost-effective alternative for solving many problems which require use of supercomputers or massively parallel computers. The primary objective of this project has been to conduct experimental research on performance evaluation for clustered parallel computing. First, a testbed was established by augmenting our existing SUNSPARCs' network with PVM (Parallel Virtual Machine) which is a software system for linking clusters of machines. Second, a set of three basic applications were selected. The applications consist of a parallel search, a parallel sort, a parallel matrix multiplication. These application programs were implemented in C programming language under PVM. Third, we conducted performance evaluation under various configurations and problem sizes. Alternative parallel computing models and workload allocations for application programs were explored. The performance metric was limited to elapsed time or response time which in the context of parallel computing can be expressed in terms of speedup. The results reveal that the overhead of communication latency between processes in many cases is the restricting factor to performance. That is, coarse-grain parallelism which requires less frequent communication between processes will result in higher performance in network-based computing. Finally, we are in the final stages of installing an Asynchronous Transfer Mode (ATM) switch and four ATM interfaces (each 155 Mbps) which will allow us to extend our study to newer applications, performance metrics, and configurations.

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Design, Construction and Testing of Annular Diffusers for High Speed Civil Transportation Combustor Applications

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1 p.

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ABSTRACT I

A theoretical and an experimental design study of subsonic flow through curved-wall annular diffusers has been initiated under this award in order to establish the most pertinent design parameters and hence performance characteristics for such devices, and the implications of their application in the design of engine components in the aerospace industries. The diffusers under this study are expected to contain appreciable regions of stall and the effects of swirl on their performance are being studied. The experimental work involves the application of Computer Aided Design software tool to the development of a suitable annular diffuse geometry and the subsequent downloading of such data to a CNC machine at Central Sate University (CSU). Two experimental run segments have been completed so far during FY-95 involving flow visualization and diffuser performance evaluation based on Kinetic Energy Dissipation. The method of calculation of the performance of diffusers based on pressure recovery coefficient has been shown to have some shortcomings and so the kinetic energy dissipation approach has been introduced in the run segment two with some success. The application of the discretized, full Navier Stokes and Continuity equations to the numerical study of the problem described above for the time-mean flow is expected to follow. Various models of turbulence are being evaluated for adoption throughout the study and comparisons would be made with experimental data where they exist. Assessment of diffuser performance based on the dissipated mechanical energy would also be made. The results of the investigations are expected to indicate that more cost effective component design of such devices as diffusers which normally contain complex flows can still be achieved.

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Research Laboratory for Engineering and Technology (ReLEnT)-Summer Program

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ABSTRACT II

During the fiscal years 1994-1995 students at Central State University (CSU) have worked diligently under the supervision of the PI and associates to plan, design and conduct a four-week hands on summer program for high school students in grades 9 to 12. These workshops consists of experiments and computer aided design and manufacturing, designed to constructively stimulate interests in engineering and technology, and promote enrollment at CSU after they matriculate from high school. In 1994, ten (10) such students were admitted into the summer program. Similarly in FY-95, twenty (20) students were admitted into the program. The experience gained in those two years will be utilized to realized one of the deliverables for CSU engineering program during 1996. In FY-96 a new total of 30 students (ten of whom must come from the FY-95 group and the remaining twenty (20) students must be from the matriculating class) are now being interviewed for the 1996 program. At the conclusion of the 1996 program a total of sixty (60) students will have participated in the CSU ReLEnT program and this offers us a potential recruitment of thirty (30) high school students into the engineering program at CSU. This grant also provides resource for students enrolled in CSU's engineering program to work as undergraduate research assistants and ReLEnT tuition scholarship awards. These students are involved in the development of research, design projects, workshop procedures, laboratory exercises and seminars. Undergraduate students receiving tuition scholarships are required to maintain a cumulative grade point average of 3.0 or higher. Finally, the ReLEnT award has made it possible for CSU to acquire some experimental and CFD capability which now provides us with the opportunity to compete and respond to RFPs on a competitive basis and a timely manner.

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Establishment of a Beta Test Center for the NPARC Code at Central State University

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ABSTRACT III

As an addendum to Abstract II, Central State University has received a supplementary award to purchase computer workstations for the NPARC (National Propulsion Ames Research Center) computational fluid dynamics code BETA Test Center. The computational code has also been acquired for installation on the workstations. The acquisition of this code is an initial step for CSU in joining an alliance composed of NASA, AEDC, The Aerospace Industry, and academia. A post-Doctoral research Fellow from a neighboring university will assist the PI in preparing a template for Tutorial documents for the BETA test center. The major objective of the alliance is to establish a national applications-oriented CFD capability, centered on the NPARC code. By joining the alliance, the BETA test center at CSU will allow the PI, as well as undergraduate and post-graduate students to test the capability of the NPARC code in predicting the physics of aerodynamic/geometric configurations that are of interest to the alliance. Currently, CSU is developing a once a year, hands-on conference/workshop based upon the experience acquired from running other codes similar to the NPARC code in the first year of this grant.

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Optimizing Process Parameters to Produce Single Phase $YBa_2Cu_3O_7$ Powder

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ABSTRACT

Process parameters such as temperature and time are varied to obtain single phase (pure) $YBa_2Cu_3O_7$ powders. X-ray diffraction patterns of superconducting and nonsuperconducting powders are observed *in situ* in normal and elevated temperature environments to confirm known strong peaks that are unique to $YBa_2Cu_3O_7$. Peaks vary in magnitude as a result of superconducting ↔ nonsuperconducting phase transitions. Known strong peaks serve as our basis in monitoring transitional changes. Peak isotherms obtained experimentally are correlated with theoretical models to identify the weighting factor that characterizes the optimum isotherm. By isolating the parameters under which 100% peak growth occurs most rapidly, we obtain the optimum isotherm. The choices made for firing temperature and atmosphere were determined to be the primary factors necessary to ensure sample purity.

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Turbulent Methane-Air Combustion

39-25
ABSTRACT
80987
034837
18.

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ABSTRACT

This study is aimed at enhancing the understanding of turbulent premixed methane-air combustion. Such understanding is essential since: (1) many industries are now pursuing lighter hydrocarbon alternative fuels and the use of premixed flames to reduce pollutant emissions, and (2) the characteristic dimensions and flow rates of most industrial combustors are often large for flows to be turbulent. The specific objectives of the study are: (1) to establish the effects of process variables (e.g., flow rate, fuel/air ratio, chlorinated hydro-carbons, and pressure) on the emissions and flow structure (velocity distribution, streamlines, vorticity and flame shape), and (2) to develop a mechanistic model to explain the observed trends. A review of the available literature and the acquisition of equipment have been completed. This includes the acquisition of Dantec FlowMap Particle Image Velocimeter. The design and fabrication of the premixed burner has also been completed. The study is now at the stage of testing of equipment and analytical instruments. This should be completed by the end of April 1996. Thereafter, future work will involve extensive data collection and analysis of the results. The presentation will give details on the tasks completed and on the current and future plans. The project is progressing well and all activities are on schedule. The outlook for the success of the project is bright.

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Momentum Transfer Studies and Studies of Linear and Nonlinear Optical Properties of Metal Colloids and Semiconductor Quantum Dots

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1 P.

W.E. Collins, A. Burger, K. Dyer, M. George, D. Henderson, S. Morgan, R. Mu, D. Shi, D. Conner,* E. Thompson, L. Collins,† L. Curry,† S. Mattox,† and G. Williams †
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ABSTRACT

Phase I of this work involved design work on a momentum transfer device. The progress on design and testing will be presented. Phase II involved the systematic study of the MPD thruster for dual uses. Though it was designed as a thruster for space vehicles, the characteristics of the plasma make it an excellent candidate for industrial applications. This project sought to characterize the system for use in materials processing and characterization. The surface modification on ZnCdTe, CdTe, and ZnTe will be presented. Phase III involved metal colloids and semiconductor quantum dots. One aspect of this project involves a collaborative effort with the Solid State Division of ORNL. The thrust behind this research is to develop ion implantation for synthesizing novel materials (quantum dots wires and wells, and metal colloids) for applications in all optical switching devices, up conversion, and the synthesis of novel refractory materials. The ions of interest are Au, Ag, Cd, Se, In, P, Sb, Ga, and As. The specific materials of interest are: CdSe, CdTe, InAs, GaAs, InP, GaP, InSb, GaSb, and InGaAs. A second aspect of this research program involves using porous glass (25-200 Å) for fabricating materials of finite size. The results of some of this work will also be reported.

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*Graduate student.

†REU/SRP undergraduate summer research program participants.

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Parallelization of Rocket Engine System Software (Press)

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ABSTRACT

This project is part of a collaborative effort with Southern University at Baton Rouge (SUBR), University of West Florida (UWF), and Jackson State University (JSU). The first-year funding involves support for the principal investigator and two graduate students enrolled in M.S. in Computer Science at Hampton University. The stipend support for graduate students in this new Masters program in Computer Science is very important. The main goal is to assess parallelization requirements for the Rocket Engine Numeric Simulator (RENS) project which, aside from gather information on liquid-propelled rocket engines and setting forth requirements, involve a large FORTRAN based package at NASA Lewis Research Center and TDK software developed by SUBR/UWF. The ultimate aim is to develop, test, integrate, and suitably deploy a family of software packages on various aspects and facets of rocket engines using liquid-propellants. At present, all project efforts by the funding agency, NASA Lewis Research Center, and the HBCU participants are disseminated over the internet using world wide web home pages. Considering obviously expensive methods of actual field trails, the benefits of software simulators are potentially enormous. When realized, these benefits will be analogous to those provided by numerous CAD/CAM packages and flight-training simulators. According to the overall task assignments, Hampton University's role is to collect all available software, place them in a common format, assess and evaluate, define interfaces, and provide integration. Most importantly, the HU's mission is to see to it that the real-time performance is assured. This involves source code translations, porting, and distribution. The porting will be done in two phases: First, place all software on Cray X-MP platform using FORTRAN. After testing and evaluation on the Cray X-MP, the code will be translated to C++ and ported to the parallel nCUBE platform (64-node MIMD machine). At present, we are evaluating another option of distributed processing over local area networks using Sun NFS, Ethernet, TCP/IP. Considering the heterogenous nature of the present software (e.g., first started as an expert system using LISP machines) which now involve FORTRAN code, the effort is expected to be quite challenging. An overview of the strategy to achieve this will be given in the oral presentation by the principal investigator.

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Expendable Launch Vehicle Studies

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ABSTRACT

Analytical support studies of expendable launch vehicles concentrates on the stability of the dynamics during launch especially during or near the region of maximum dynamic pressure. The in-plane linearized dynamic equations of a generic launch vehicle with multiple flexible bending and fuel sloshing modes are developed. When the fuel slosh is included in the plant model, the system will be 22nd order. The design of the smallest reduced order (7th order) H_∞ robust controller for the launch vehicle has been finished. The simulation indicates that both the performance and robustness of the 7th order H_∞ robust controller are better than that of the classical PID controller. Also it has already been investigated that the LQR controller has better performance than that of the PID. To solve the problem of full state feedback, a state estimator has been successfully developed, such that after only 2-3 sec there is no noticeable difference between the estimated states and the real ones. The system, however, is high ordered and less robust. The design of a robust LQR controller based on the reduced order system is accomplished using the parameter perturbation technique. The investigation of the sensor redundancy problem shows that both rate sensors, the forward as well as the aft, in combination with the position sensor are essential for the system stability of the launch vehicle under consideration. This means that elimination of one or both rate sensors will destabilize the system. The ELV modeling and analysis team has spent the past three years working on the theoretical development and application of sensitivity analysis to solve eigenvalue problems associated with structural dynamics. Specific application areas include stochastic vibrations, viscously damped vibrations and nonlinear dynamics. In stochastic linear vibrations, sensitivity analysis methods have been developed which determined the expectation and variance of the response for given probability density functions of various stochastic parameters. Examples worked include beam vibrations with up to six stochastic parameters; and the eigensensitivity results differ little from those obtained, with much effect, from Monte Carlo techniques. For viscously damped vibrations, eigensensitivity analysis has given excellent results for homogeneous beams, modeled by either quadratic or quartic eigenvalue equations. Specific applications include Kevin and Maxwell-type viscoelastic beams. A masters thesis was successfully completed on this subject

in December, 1995. Research in the final application area, non-linear dynamics, is still in progress. Periodic responses have been modeled as a non-linear eigenvalue problem, and the theory developed has provided excellent closed-form approximate solutions. For non-periodic motion, methodology has been developed which can handle up to six coupled non-linear initial-valued differential equations.

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Determination of Thermal State of Charge in Solar Heat Receivers

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ABSTRACT

The research project at Howard University seeks to develop analytical and numerical capabilities to study heat transfer and fluid flow characteristics, and the prediction of the performance of solar heat receivers for space applications. Specifically, the study seeks to elucidate the effects of internal and external thermal radiation, geometrical and applicable dimensionless parameters on the overall heat transfer in space solar heat receivers. Over the last year, a procedure for the characterization of the state-of-charge (SOC) in solar heat receivers for space applications has been developed. By identifying the various factors that affect the SOC, a dimensional analysis is performed resulting in a number of dimensionless groups of parameters. Although not accomplished during the first phase of the research, data generated from a thermal simulation program can be used to determine values of the dimensionless parameters and the state-of-charge and thereby obtain a correlation for the SOC. The simulation program selected for the purpose is HOTTube, a thermal numerical computer code based on a transient time-explicit, axisymmetric model of the total solar heat receiver. Simulation results obtained with the computer program are presented the minimum and maximum insolation orbits. In the absence of any validation of the code with experimental data, results from HOTTube appear reasonable qualitatively in representing the physical situations modeled.

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Flame Characterization Using a Tunable Solid-State Laser With Direct UV Pumping

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ABSTRACT

Tunable solid-state lasers with direct UV pumping, based on d-f transitions of rare earth ions incorporated in wide band-gap dielectric crystals, are reliable sources of laser radiation that are suitable for excitation of combustion-related free radicals. We have employed such a laser for analytical flame characterization utilizing laser-induced fluorescence (LIF) techniques. LIF spectra of alkane-air flames (used for studying combustion processes under normal and microgravity conditions) excited in the region of the A-X (0,0) OH-absorption band have been recorded and found to be both temperature-sensitive and positionally-sensitive. In addition, also clearly noticeable was the sensitivity of the spectra to the specific wavelength used for data registration. LIF excitation spectra of a propane-air flame were obtained with registration wavelengths of 324 and 330 nm using a tunable LiCAF:Ce laser of bandwidth 0.001 nm as an excitation source. Distinctive anomalous alkane-air flame features make the two spectra recorded with registration wavelengths 6 nm apart appear quite different, where the bandwidth for spectral registration was 4 nm full-width half maximum (FWHM). Such differences will prove very useful of monitoring combustion processes occurring in flames under microgravity conditions. The LiCAF:Ce laser shows good prospects for being able to cover the spectral region between 280 and 340 nm and therefore be used for excitation of combustion-intermediates, such as the hydroxyl (OH), methoxy (CH_3O) and methylthio (CH_3S) radicals. Such wavelength tunability based on a multisite LiCAF:Ce crystal holds promise for the development of a widely tunable protable analytical unit for flames characterization that can be used for spaceborne microgravity experiments.

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Epitaxial Growth of β-Silicon Carbide (SiC) on a Compliant Substrate via Chemical Vapor Deposition (CVD)

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ABSTRACT

Many lattice defects have been attributed to the lattice mismatch and the difference in the thermal coefficient of expansion between SiC and silicon (Si). Stacking faults, twins and antiphase boundaries are some of the lattice defects found in these β-SiC films. These defects may be a partial cause of the disappointing performance reported for the prototype devices fabricated from β-SiC films. The objective of this research is to relieve some of the thermal stress due to lattice mismatch when SiC is epitaxially grown on Si. The compliant substrate is a silicon membrane 2-4 μm thick. The CVD process includes the buffer layer which is grown at 1360 °C followed by a very thin epitaxial growth of SiC. Then the temperature is raised to 1500 °C for the subsequent growth of SiC. Since silicon melts at 1415 °C, the SiC will be grown on molten Silicon which is absorbed by a porous graphite susceptor, eliminating the SiC/Si interface. We suspect that this buffer layer will yield less stressed material to help in the epitaxial growth of SiC.

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Application of Hybrid Optimization-Expert System for Optimal Power Management on Board Space Power Station

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ABSTRACT

The space power system has two sources of energy: photo-voltaic blankets and batteries. The optimal power management problem on-board has two broad operations: off-line power scheduling to determine the load allocation schedule of the next several hours based on the forecast of load and solar power availability. The nature of this study puts less emphasis on speed requirement for computation and more importance on the optimality of the solution. The second category problem, on-line power rescheduling, is needed in the event of occurrence of a contingency to optimally reschedule the loads to minimize the "unused" or "wasted" energy while keeping the priority on certain type of load and minimum disturbance of the original optimal schedule determined in the first-stage off-line study. The computational performance of the on-line "rescheduler" is an important criterion and plays a critical role in the selection of the appropriate tool. The Howard University Center for Energy Systems and Control has developed a hybrid optimization-expert systems based power management program. The pre-scheduler has been developed using a non-linear multi-objective optimization technique called the Outer Approximation method and implemented using the General Algebraic Modeling System (GAMS). The optimization model has the capability of dealing with multiple conflicting objectives viz. maximizing energy utilization, minimizing the variation of load over a day, etc. and incorporates several complex interaction between the loads in a space system. The rescheduling is performed using an expert system developed in PROLOG which utilizes a rule-base for reallocation of the loads in an emergency condition viz. shortage of power due to solar array failure, increase of base load, addition of new activity, repetition of old activity etc. Both the modules handle decision making on battery charging and discharging and allocation of loads over a time-horizon of a day divided into intervals of 10 minutes. The models have been extensively tested using a case study for the Space Station Freedom and the results for the case study will be presented. Several future enhancements of the pre-scheduler and the "rescheduler" have been outlined which include graphic analyzer for the on-line module, incorporating probabilistic considerations, including spatial location of the loads and the connectivity using a direct current (DC) load flow model. This power management scheme will benefit NASA by providing an efficient load allocation

scheme and also for dealing with emergency conditions in the space power system. The HU faculty and students will also be immensely benefitted from applying the state-of-the-art optimization and AI tools to space power system management problem.

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Advanced Intelligent System Application to Load Forecasting and Control for Hybrid Electric Bus

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ABSTRACT

The primary motivation for this research emanates from providing a decision support system to the electric bus operators in the municipal and urban localities which will guide the operators to maintain an optimal compromise among the noise level, pollution level, fuel usage etc. This study is backed up by our previous studies on study of battery characteristics, permanent magnet DC motor studies and electric traction motor size studies completed in the first year. The operator of the Hybrid Electric Car must determine optimal power management schedule to meet a given load demand for different weather and road conditions. The decision support system for the bus operator comprises three sub-tasks viz. forecast of the electrical load for the route to be traversed divided into specified time periods (few minutes); deriving an optimal "plan" or "pre-schedule" based on the load forecast for the entire time-horizon (i.e., for all time periods) ahead of time; and finally employing corrective control action to monitor and modify the optimal plan in real-time. A fully connected artificial neural network (ANN) model is developed for forecasting the kW requirement for hybrid electric bus based on inputs like climatic conditions, passenger load, road inclination, etc. The ANN model is trained using back-propagation algorithm employing improved optimization techniques like projected Lagrangian technique. The pre-scheduler is based on a goal-programming (GP) optimization model with noise, pollution and fuel usage as the three objectives. GP has the capability of analyzing the trade-off among the conflicting objectives and arriving at the optimal activity levels, e.g., throttle settings. The corrective control action or the third sub-task is formulated as an optimal control model with inputs from the real-time data base as well as the GP model to minimize the error (or deviation) from the optimal plan. These three activities linked with the ANN forecaster proving the output to the GP model which in turn produces the pre-schedule of the optimal control model. Some preliminary results based on a hypothetical test case will be presented for the load forecasting module. The computer codes for the three modules will be made available for adoption by bus operating agencies. Sample results will be provided using these models. The software will be a useful tool for supporting the control systems for the Electric Bus project of NASA. Besides that the students and faculty members at HU will be benefitted

from on-hand experiment with the state-of-the-art AI application tools for designing hybrid electric bus control system.

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Howard University Energy Expert Systems Institute Summer Program (EESI)

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ABSTRACT

Howard University, under the auspices of the Center for Energy Systems and Controls runs the Energy Expert Systems Institute (EESI) summer outreach program for high school/pre-college minority students. The main objectives are to introduce pre-college minority students to research in the power industry using modern state-of-the-art technology such as Expert Systems, Fuzzy Logic and Artificial Neural Networks; to involve minority students in space power management, systems and failure diagnosis; to generate interest in career options in electrical engineering; and to experience problem-solving in a teamwork environment consisting of faculty, senior research associates and graduate students. For five weeks the students are exposed not only to the exciting experience of college life, but also to the inspiring field of engineering, especially electrical engineering. The program consists of lectures in the fundamentals of engineering, mathematics, communication skills and computer skills. The projects are divided into mini and major. Topics for the 1995 mini projects were *Expert Systems for the Electric Bus and Breast Cancer Detection*. Topics on the major projects include *Hybrid Electric Vehicle, Solar Dynamics and Distribution Automation*. On the final day, designated as *"EESI Day"*, the students did oral presentations of their projects and prizes were awarded to the best group. The program began in the summer of 1993. In 1994 and 1995 it attracted over fifteen participants from all over the world. The reaction from the students has been very positive. Our initial survey revealed that nearly 85% of the participants eventually attend college. In fact some of the top scores in the Scholastic Aptitude Test (SAT) for 1995 came from the 1995 EESI students. Two of these students are presently enrolled in the electrical engineering department at Howard. The program also arranges field trips to special places of interest such as the NASA Goddard Space Center. The large number of applications so far for the 1996 program attest to the fact that this program is greatly valued and sought after by the community at large

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Solar Dynamic Power System Fault Diagnosis

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ABSTRACT

The objective of this research is to conduct various fault simulation studies for diagnosing the type and location of faults in the power distribution system. Different types of faults are simulated at different locations within the distribution system and the faulted waveforms are monitored at measurable nodes such as at the output of the DDCUs. These fault signatures are processed using feature extractors such as FFT and wavelet transforms. The extracted features are fed to a clustering based neural network for training and subsequent testing using previously unseen data. Different load models consisting of constant impedance and constant power are used for the loads. Open circuit faults and short circuit faults are studied. It is concluded from present studies that using features extracted from wavelet transforms give better success rates during ANN testing. The trained ANNs are capable of diagnosing fault types and approximate locations in the solar dynamic power distribution system. The results will be presented at the conference.

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Fault Diagnosis of Power Systems Using Intelligent Systems

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ABSTRACT

The power system operator's need for a reliable power delivery system calls for a real-time or near-real-time AI-based fault diagnosis tool. Such a tool will allow NASA ground controllers to re-establish a normal or near-normal degraded operating state of the EPS (a DC power system) for Space Station Alpha by isolating the faulted branches and loads of the system. And after isolation, re-energizing those branches and loads that have been found not to have any faults in them. A proposed solution involves using the Fault Diagnosis Intelligent System (FDIS) to perform near-real time fault diagnosis of Alpha's EPS by downloading power transient telemetry at fault-time from onboard data loggers. The FDIS uses an ANN clustering algorithm augmented with a wavelet transform feature extractor. This combination enables this system to perform pattern recognition of the power transient signatures to diagnose the fault type and its location down to the orbital replaceable unit. FDIS has been tested using a simulation of the LeRC Testbed Space Station Freedom configuration including the topology from the DDCU's to the electrical loads attached to the TPDU's. FDIS will work in conjunction with the Power Management Load Scheduler to determine what the state of the system was at the time of the fault condition. This information is used to activate the appropriate diagnostic section, and to refine if necessary the solution obtained. In the latter case, if the FDIS reports back that it is equally likely that the faulty device as "start tracker #1" and "time generation unit," then based on a priori knowledge of the system's state, the refined solution would be "star tracker #1" located in cabinet ITAS2. It is concluded from the present studies that artificial intelligence diagnostic abilities are improved with the addition of the wavelet transform, and that when such a system such as FDIS is coupled to the Power Management Load Scheduler, a faulty device can be located and isolated from the rest of the system. The benefit of these studies provides NASA with the ability to quickly restore the operating status of a space station from a critical state to a safe degraded mode, thereby saving costs in experimentation rescheduling, fault diagnostics, and prevention of loss-of-life. Further, this research can be extended to other NASA projects such as Solar Dynamics.

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Design of Power System Architectures for Small Spacecraft Systems

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ABSTRACT

The objective of this research is to perform a trade study on several candidate power system architectures for small spacecrafts to be used in NASA's new millennium program. Three initial candidate architectures have been proposed by NASA and two other candidate architectures have been proposed by Howard University. Howard University is currently conducting the necessary analysis, synthesis, and simulation needed to perform the trade studies and arrive at the optimal power system architecture. Statistical, sensitivity and tolerant studies has been performed on the systems. It is concluded from present studies that certain components such as the series regulators, buck-boost converters and power converters can be minimized while retaining the desired functionality of the overall architecture. This in conjunction with battery scalability studies and system efficiency studies have enabled us to develop more economic architectures. Future studies will include artificial neural networks and fuzzy logic to analyze the performance of the systems. Fault simulation studies and fault diagnosis studies using EMTP and artificial neural networks will also be conducted.

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Solar Dynamic Power System Stability Analysis and Control

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ABSTRACT

The objective of this research is to conduct dynamic analysis, control design, and control performance test of solar power system. Solar power system consists of generation system and distribution network system. A bench mark system is used in this research, which includes a generator with excitation system and governor, an ac/dc converter, six DDCUs and forty-eight loads. A detailed model is used for modeling generator. Excitation system is represented by a third order model. Turbine and governor are model by a second order system. Constant voltage control is applied to the ac/dc converter. DDCU is represented by a seventh order system. The load is modeled by the combination of constant power and constant impedance. Eigen-analysis and eigen-sensitivity analysis are used for system dynamic analysis. The effects of excitation system, governor, ac/dc converter control, and the type of load on system stability are discussed. In order to improve system transient stability, nonlinear ac/dc converter control is introduced. The direct linearization method is used for control design. The control performance test is carried out under both load change and fault condition. The dynamic analysis results show that these controls affect system stability in different ways. The parameter coordination of controllers are recommended based on the dynamic analysis. The performance test shows that the present control can stabilize system under both load disturbance and fault condition. It is concluded from the present studies that system stability is improved by the coordination of control parameters and the nonlinear ac/dc converter control stabilize system oscillation caused by the load change and system fault efficiently. The results obtained are very promising. The present methods are expected to be extended to NASA test solar power system stability analysis and to improve system stability operation.

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On-line Tracking Controller for Brushless DC Motor Drives Using Artificial Neural Networks

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ABSTRACT

A real-time control architecture is developed for time-varying nonlinear brushless dc motors operating in a high performance drives environment. The developed control architecture possesses the capabilities of simultaneous on-line identification and control. The dynamics of the motor are modeled on-line and controlled using an artificial neural network, as the system runs. The control architecture combines the experience and dependability of adaptive tracking systems with potential and promise of the neural computing technology. The sensitivity of real-time controller to parametric changes that occur during training is investigated. Such changes are usually manifested by rapid changes in the load of the brushless motor drives. This sudden change in the external load is simulated for the sigmoidal and sinusoidal reference tracks. Simulations show that the neuro-controller needs to be trained for longer periods, but eventually succeeds in capturing the dynamics of the rapid load changes in process of emulating the nonlinear dynamics of the motor drives. The ability of the neuro-controller to maintain reasonable tracking accuracy in the presence of external noise is also verified for a number of desired reference trajectories. The simulations suggest that it is physically practical to implement this system in a laboratory setup. Implementation of the control architecture on actual hardware will form the basis for future work.

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The Conservation/Solution Element (STE) Method for Linear Potential Flow Problems

D34869

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ABSTRACT

The potential equation is discretized on rectangular domains using the Conservation/Solution Element Method (STE) approach. Computational examples with a discussion of numerical experience gained are given.

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An NMR Study of Microvoids in Polymers

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ABSTRACT

An understanding of polymer defect structures, like microvoids in polymeric matrices, is most crucial to their fabrication and application potential. In this project guest atoms are introduced into the microvoids in PMR-15 and NMR is used to determine microvoid sizes and locations. Xenon is a relatively inert probe that would normally not be found naturally in polymer or in NMR probe materials. There are two NMR active Xenon isotopes, ^{129}Xe and ^{131}Xe. The Xe atom has a very high polarizability, which makes it sensitive to the intracrystalline environment of polymers. Interactions between the Xe atoms and the host matrix perturb and Xe electron cloud, deshielding the nuclei, and thereby expanding the range of the observed NMR chemical shifts. This chemical shift range which may be as large as 5000 ppm, permits subtle structural and chemical effects to be studied with high sensitivity. The ^{129}Xe-NMR line shape has been found to vary in response to changes in the pore symmetry of the framework hosts in Zeolites and Clathrasil compounds. Before exposure to Xe gas, the PMR-15 samples were dried in a vacuum oven at 150 °C for 48 hours. The samples were then exposed to Xe gas at 30 psi for 72 hours and sealed in glass tubes with 1 atmosphere of Xenon gas. Xenon gas at 1 atmosphere was used to tune up the spectrometer and to set up the appropriate NMR parameters. A single ^{129}Xe line at 83.003498 MHz (with protons at 300 MHz) was observed for the gas. A series of spectra were obtained interspersed with applications of vacuum and heating to drive out the adsorbed Xe and determine the role of Xe-Xe interactions in the observed chemical shift. With the xenon charged PMR-15 samples a second broader line is observed 190 ppm downfield from the gas line (also observed). The width of the NMR line from the ^{129}Xe absorbed in the polymer is at least partially due to the distribution of microvoid sizes. From the chemical shift (relative to the gas line) and the linewidth, based on a Van der Waals interaction energy model we estimate the average void sizes to be 2.74 ± 0.20 angstorms. Since ^{129}Xe has such a large chemical shift range (~5000 ppm), we expect the chemical shift anisotropy to contribute to the linewidth ($\delta\nu$ = 2.5 kHz).

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Experiments Related to the Fabrication of Carbon Fiber/AMB-21 Polyimide Composite Tubes Using the RTM Process

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ABSTRACT

AMB-21 is a new polymer developed by Mr. Ray Vannucci, NASA, LeRC as a non-carcinogenic polyimide matrix which may be suitable for fabricating composite parts by the Resin Transfer Modeling (RTM) process. The polyimide for this project was prepared at the Center of Composite Materials Research at N.C. A&T State University because it is not currently an item of commerce. The RTM process is especially suitable for producing geometrically complex composite parts at a low cost. Because of the high melting point and very high viscosity at the time of processing, polyimides have not been extensively used in the RTM process. The process for preparing AMB-21 as well as the process for fabricating composite plates will be described. The basic fabrication process consists of injecting a solvent solution of AMP-21 into a carbon fiber preform, evaporating the solvent, imidizing the polyimide, and vacuum/compression modeling the impregnated preform. All the above molding steps are preformed in a specially designed RTM mold which will be described. The results of this process have been inconsistent. Where as some experiments have resulted in a reasonably sound panels, others have not. Further refinements of the process are required to establish a reliable process.

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Graphite Fiber Textile Preform/Copper Matrix Composites

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ABSTRACT

Graphite fiber reinforced/copper matrix composites are candidate materials for critical heat transmitting and rejection components because of their high thermal conduction. The use of textile (braid) preforms allows near-net shapes which confers additional advantages, both for enhanced thermal conduction and increased robustness of the preform against infiltration and handling damage. Issues addressed in the past year center on the determination of the braid structure following infiltration, and the braidability vs. the conductivity of the fibers. Highly conductive fibers eventuate from increased graphitization, which increases the elastic modulus, but lowers the braidability; a balance between these factors must be achieved. Good quality braided preform bars have been fabricated and infiltrated, and their thermal expansion characterized; their analytic modeling is underway. The braided preform of an integral finned tube has been fabricated and is being prepared for infiltration.

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A CFD Study of Turbojet and Single-Throat Ramjet Ejector Interaction

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ABSTRACT

Supersonic ejector-diffuse systems have application in driving an advanced air-breathing propulsion system, consisting of turbojet engines acting as the primary and a single throat ramjet acting as the secondary. The turbojet engines are integrated into the single throat ramjet to minimize variable geometry and eliminate redundant propulsion components. The result is a simple, lightweight system that is operable from takeoff to high Mach numbers. At this high Mach number (approximately Mach 3.0), the turbojets are turned off and the high speed ramjet/scramjet take over and drive the vehicle to Mach 6.0. The turbojet-ejector-ramjet system consists of nonafterburning turbojet engines with ducting canted at 20 degrees to supply supersonic flow (downstream of C-D nozzle) to the horizonal ramjet duct at a supply total pressure and temperature. This flow interacts in ejector mode with the secondary ramjet acting at total conditions prescribed by the inlet recovery conditions. If the secondary flow chokes in the mixing zone, maximum flow is obtained in the ramjet duct. This is known as the Fabri choke condition. As the downstream backpressure is increased, the Fabri choke condition can no longer exist and the ramjet flow is reduced and the ejector is no longer back pressure independent. These two conditions were modelled by a 2-D full Navier Stokes code at Mach 2.0. The code modelled the Fabri choke as well as the non-Fabri non critical case, using a computational throat to supply the back pressure. The results, which primarily predict the secondary mass flow rate and the mixed conditions at the ejector exit were in reasonable agreement with the 1-D cycle code (TBCC). Future work includes modelling the hydrogen spray bar located in the entrance region of the nozzle, to supply the back pressure, instead of the computation flowplug.

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A Cost Comparison of Alternative Approaches to Distance Education in Developing Countries

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ABSTRACT

This paper presents a cost comparison of three approaches to two-way interactive distance learning systems for developing countries. Included are costs for distance learning hardware, terrestrial and satellite communication links, and designing instruction for two-way interactive courses. In September 1994, NASA Lewis Research Center entered into a cooperative agreement with Savannah State College (SCC) and the Florida Solar Energy Center (FSEC) for a project entitled "ACTS for Distance Education in Developing Countries." As part of this project, FSEC is developing a 30-hour course in photovoltaic system design that will be used in a variety of experiments using the Advanced Communications Technology Satellite (ACTS). A primary goal of the project is to develop an instructional design and delivery model that can be used for other education and training programs. Presently, many of the international training efforts in energy are through U.S. Department of Energy programs. The U.S. photovoltaic industry is also actively involved in training and there is considerable competition with Europe and Japan for international markets. Over two-thirds of the world photovoltaics market is in developing countries. Because of poor economic conditions in the developing countries, much of the funding for programs and equipment comes from multilateral organizations. One of the objectives of this NASA-sponsored project was to develop new and better energy education programs that take advantage of advances in telecommunications and computer technology. The combination of desktop video systems and the sharing of computer applications software is of special interest. Research is being performed to evaluate the effectiveness of some of these technologies as part of this project. The design of the distance learning origination and receive sites discussed in this paper were influenced by the educational community's growing interest in distance education. The following approach was used to develop comparative costs for delivering interactive distance education to developing countries: (1) Representative target locations for receive sites were chosen. The originating site was assumed to be Cocoa, Florida, where FSEC is located; (2) A range of course development costs were determined; (3) The cost of equipment for three alternative two-way interactive distance learning system configurations was determined or estimated. The types of system configurations ranged from a PC-based system that allows instructors to originate instruction from their offices using desktop video and shared application software, to a high cost system that uses an electronic classroom; (4) A range of costs for both satellite and terrestrial communications was investigated; (5) The costs of equipment and operation of the alternative configurations for the origination and receive sites

were determined; (6) A range of costs for several alternative delivery scenarios (i.e., a mix of live-interactive; asynchronous interactive; use of video tapes) was determined; and (7) A preferred delivery scenario, including cost estimates, was developed.

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Knowledge Engineering for Preservation and Future Use of Institutional Knowledge

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ABSTRACT

This Project has two main thrusts—preservation of special knowledge and its useful representation via computers. NASA is losing the expertise of its engineers and scientists who put together the great missions of the past. We no longer are landing men on the moon. Some of the equipment still used today (such as the RL-10 rocket) was designed decades ago by people who are now retiring. Furthermore, there has been a lack, in some areas of technology, of new projects that overlap with the old and that would have provided opportunities for monitoring by senior engineers of the young ones. We are studying this problem and trying out a couple of methods of soliciting and recording rare knowledge from experts. One method is that of Concept Maps which produces a graphical interface to knowledge even as it helps solicit that knowledge. We arranged for experienced help in this method from John Coffey of the Institute of Human and Machine Technology at the University of West Florida. A second method which we plan to try out in May, is a video-taped review of selected failed missions (e.g., the craft tumbled and blew up). Five senior engineers (most already retired from NASA) will, as a team, analyze available data, illustrating their thought processes as they try to solve the problem of why a space craft failed to complete its mission. The session will be captured in high quality audio and with at least two video cameras. The video can later be used to plan future concept mapping interviews and, in edited form, be a product in itself. Our computer representations of the amassed knowledge may eventually, via the methods of expert systems, be joined with other software being prepared as a suite of tools to aid future engineers designing rocket engines. In addition to representation by multimedia concept maps, we plan to consider linking vast bodies of text (and other media) by hypertexting methods.

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Implementation of Probabilistic Design Methodology at Tennessee State University

039013
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ABSTRACT

Engineering Design is one of the most important areas in engineering education. Deterministic Design Methodology is the only design method that is taught in most engineering schools. This method does not give a direct account of uncertainties in design parameters. Hence, it is impossible to quantify the uncertainties in the response and the actual safety margin remains unknown. The desire for a design methodology that can identify the primitive (random) variables that affect the structural behavior has led to a growing interest on probabilistic design methodology (PDM). This method is gaining more recognition in industries than in educational institutions. Some of the reasons for the limited use of the PDM at the moment are that many are unaware of its potentials, and most of the software developed for PDM are very recent. The central goal of the PDM project at Tennessee State University is to introduce engineering students to the method. The students participating in the project learn about PDM and the computer codes that are available to the design engineer. The software being used of this project is NESSUS (Numerical Evaluation of Stochastic Structures Under Stress) developed under NASA probabilistic structural analysis program. NESSUS has three different modules which make it a very comprehensive computer code for PDM. A good number of students are participating in this project and have acquired a good knowledge of the program. A research in technology transfer through course offering in PDM is in effect at Tennessee State University. The aim is to familiarize students with the problem of uncertainties in engineering design. As the students are increasing their understanding on PDM, they are at the same time applying it to some common design problems. Included in the paper are some projects on PDM carried out by some students and faculty. The areas this method is being applied at the moment include, Design of Gears (spur and worm); Design of Shafts; Design of Statistically Indeterminate Frame Structures; Design of Helical Springs; and Design of Shock Absorbers. Some of the current results of these projects are presented.

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Robust Integrated Neurocontroller for Complex Dynamic Systems

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ABSTRACT

The goal of this research effort is to develop an integrated control software environment for the purpose of creating an intelligent neurocontrol system. The system will be capable of estimating states, identifying parameters, diagnosing conditions, planning control strategies, and producing intelligent control actions. The distinct features of such control system are: adaptability and on-line learning capability. The proposed system will be flexible to allow structure adaptability to account for changes in the dynamic system such as: sensory failures and/or component degradations. The developed system should learn system uncertainties and changes, as they occur, while maintaining minimal control level on the dynamic system. The research activities set to achieve the research objective are summarized by the following general items:

1. Development of a system identifier or diagnostic system,
2. Development of a robust neurocontroller system, and
3. Integration of above systems to create a Robust Integrated Control system (RIC-system).

Two contrary approaches are investigated in this research: classical (traditional) design approach, and the simultaneous design approach. However, in both approaches neural network is the base for the development of different functions of the system. The two resulting designs will be tested and simulation results will be compared for better possible implementation.

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Sputtering Erosion in Ion and Plasma Thrusters

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ABSTRACT

Low energy sputtering of molybdenum, tantalum and boron nitride with xenon ions are being studied using secondary neutral and secondary ion mass spectrometry (SNMS/SIMS). An ultrahigh vacuum chamber was used to conduct the experiment at a base pressure of $1x10^{-9}$ torr. The primary ion beam is generated by an ion gun which is capable of delivering ion currents in the range of 20 to 500 nA. The ion beam can be focused to a spot size of approximately 1 mm in diameter. The mass spectrometer is positioned 10 mm from the target and 90° to the primary ion beam direction. SNMS and SIMS spectra were collected at various incident angles and different ion energies. For boron nitride sputtering, the target was flooded with an electron beam to neutralize the charge buildup on the surface. In the SNMS mode, sputtering of Mo and Ta can be detected at an ion energy as low as 100 eV whereas in boron nitride the same was observed up to an energy of 300 eV. However, in the positive-SIMS mode, the sputtering of Mo was observed at 10 eV incident ion energy. The SIMS spectra obtained for boron nitride clearly identifies the two isotopes of boron as well as cluster ions such as B_2^+ and molecular ions such as BN^+. From the angle versus yields measurements, it was found that the maximum SNMS yield shifts towards lower incident angles at low ion energies for all three samples.

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Research Institute for Technical Careers

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ABSTRACT

The NASA research grant to Wilberforce University enabled us to establish the Research Institute for Technical Careers (RITC) in order to improve the teaching of science and engineering at Wilberforce. The major components of the research grant are infrastructure development, establishment of the Wilberforce Intensive Summer Experience (WISE), and Joint Research Collaborations with NASA Scientists.

A. Infrastructure Development
The NASA grant has enabled us to improve the standard of our chemistry laboratory and establish the electronics, design, and robotics laboratories. These laboratories have significantly improved the level of instruction at Wilberforce University.

B. Wilberforce Intensive Summer Experience (WISE)
The WISE program is a science and engineering bridge program for pre-freshman students. It is an intensive academic experience designed to strengthen students' knowledge in mathematics, science, engineering, computing skills, and writing.

C. Joint Collaboration
Another feature of the grant is research collaborations between NASA Scientists and Wilberforce University Scientists. These collaborations have enabled our faculty and students to conduct research at NASA Lewis during the summer and publish research findings in various journals and scientific proceedings.

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Nonstandard Finite Difference Schemes: Relations Between Time and Space Step-Sizes in Numerical Schemes for PDE's That Follow From Positivity Condition

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ABSTRACT

A large class of physical phenomena can be modeled by evolution and wave type partial differential equations (PDE). Few of these equations have known explicit exact solutions. Finite-difference techniques are a popular method for constructing discrete representations of these equations for the purpose of numerical integration. However, the solutions to the difference equations often contain so called numerical instabilities; these are solutions to the difference equations that do not correspond to any solution of the PDE's. For explicit schemes, the elimination of this behavior requires functional relations to exist between the time and space steps-sizes. We show that such functional relations can be obtained for certain PDE's by use of a positivity condition. The PDE's studied are the Burgers, Fisher, and linearized Euler equations.

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Numerical Simulations of Wing-Body Junction Flows

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ABSTRACT

The goal of the research project is to contribute to the optimized design of fan bypass systems in advanced turbofan engines such as the *Advanced Ducted Propulsors* (ADP). The immediate objective is to perform numerical simulation of duct-strut interactions to elucidate the loss mechanisms associated with this configuration that is characteristic of ADP. These numerical simulations would complement an experimental study being undertaken at Purdue University. As the first step in the process, a numerical study of wing-body junction flow is being undertaken as it shares a number of characteristics with the duct-strut interaction flow. The presence of the characteristic horseshoe vortex and the associated secondary flow are the salient features that contribute to making this flow a challenge to predict numerically. The simulations will be performed with the NPARC code on the CRAY Y-MP platform at LeRC. The grids for the simulation have been generated using an algebraic mapping technique with a multisurface algorithm.

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WHY COSTING IS IMPORTANT ON HBCU GRANTS

WHY IS COST IMPORTANT?

COST IS OUR ONLY FISCAL MEASURE OF ACTUAL WORK ACCOMPLISHMENT. IT CAN BE UTILIZED BY MANAGEMENT TO EVALUATE THE EFFICIENCY & EFFECTIVENESS OF BUDGET EXECUTION ON OUR PROGRAMS.

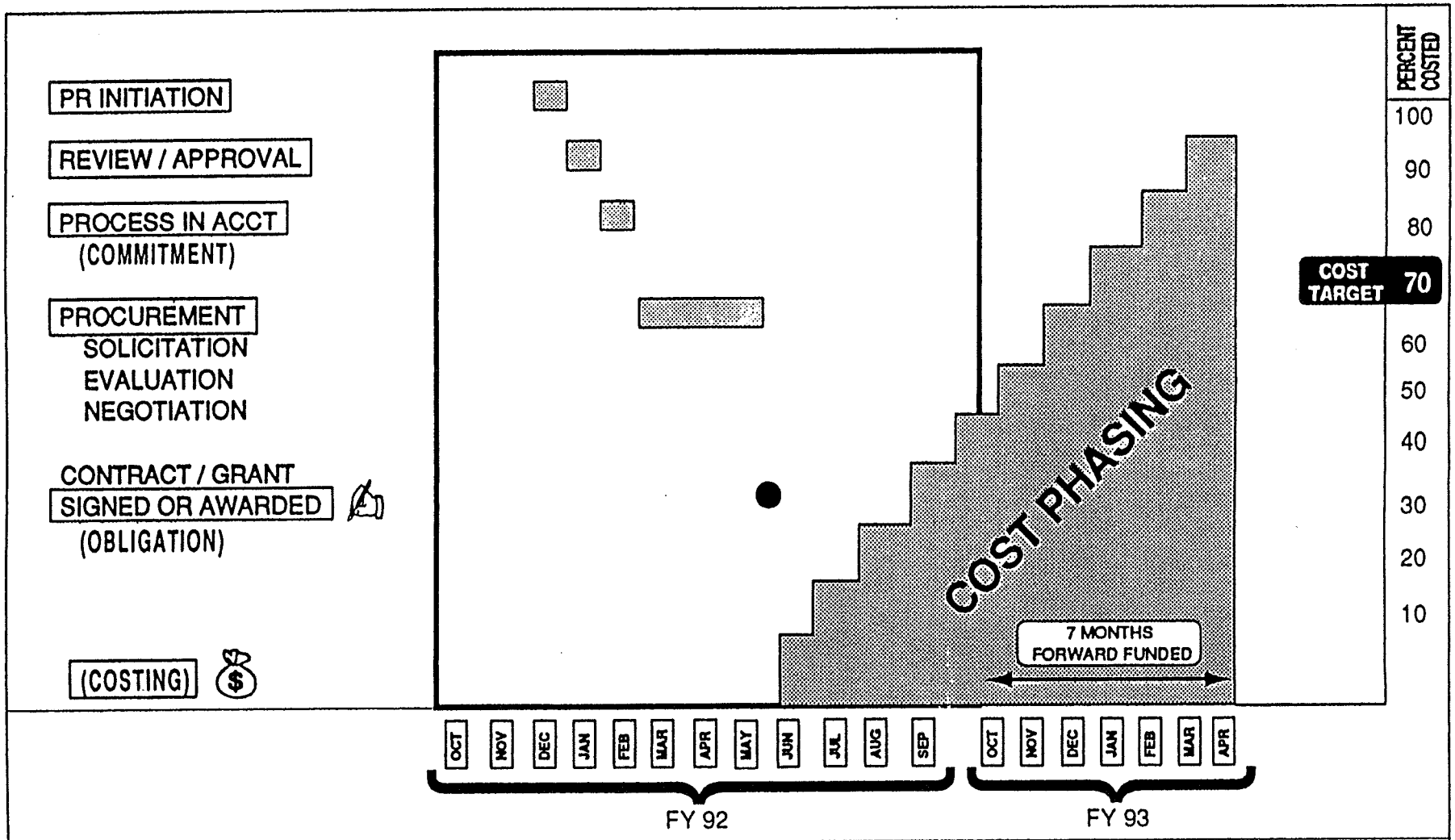
WHAT DOES FORWARD FUNDING MEAN?

FORWARD FUNDING IS EXPRESSED AS EITHER

① THE AMOUNT OF FUNDING THAT ONE'S PROGRAM OR CONTRACT WILL NOT "COST" DURING THE CURRENT FISCAL YEAR. OR

② THE PERIOD OF TIME THAT YOUR CONTRACT IS FORWARD FUNDED INTO THE NEXT FISCAL YEAR. (NOTE: RB's GUIDELINE IS THAT FORWARD FUNDING BE LIMITED TO NO MORE THAN 2 MONTHS ON ALL OAST CONTRACTS)

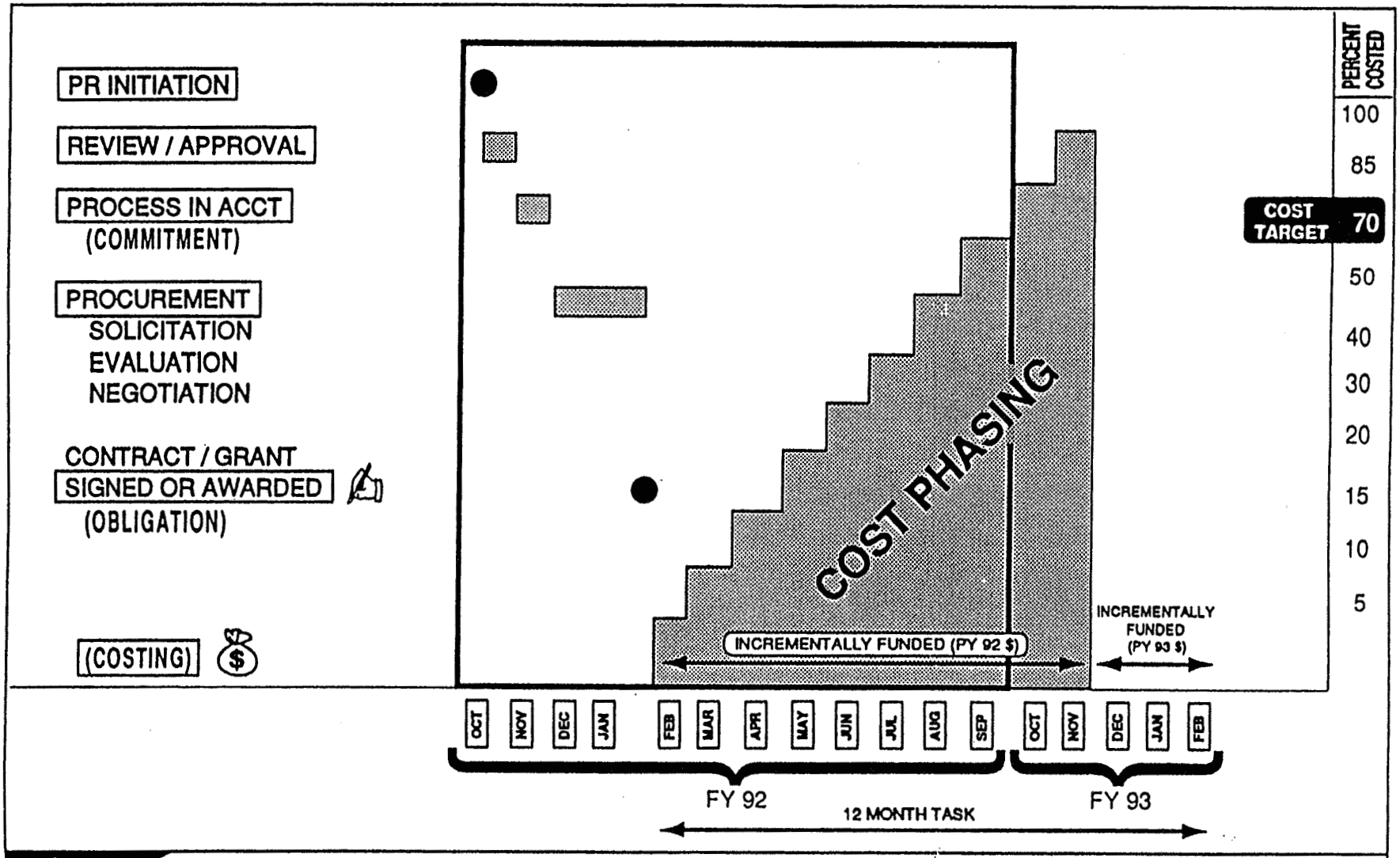
EXAMPLE OF POOR COST MANAGEMENT



KEY POINTS:

- EARLY RTOP APPROVAL AND EARLY 506 RELEASE NEED TO TRANSLATE INTO EARLY COMMITMENTS AND OBLIGATIONS
- YOU CAN'T COST FUNDS THAT ARE NOT OBLIGATED -- LATE FISCAL YEAR CONTRACT AWARDS EQUATE TO MINIMAL COST

EXAMPLE OF GOOD COST MANAGEMENT



KEY POINTS:

- EARLY PR INITIATION / COMMITEMNT
- TIMELY OBLIGATION / CONTRACT AWARD (BY MID-YEAR)
- COSTING BEGINS IN TIME TO EFFECTIVELY USE THE BUDGETED FUNDS FOR CURRENT YEAR RESEARCH WORK

COST MANAGEMENT

⚙ CHECKING ACCOUNT ANALOGY ⚙

- CODE R POLICY ALLOWS 2 MONTHS OF FORWARD FUNDING ON CONTRACTS (BEYOND 9/30) AND A CARRYOVER OF 30% OF YOUR BUDGET ALLOCATION TO COVER EXPENDITURES IN THE FOLLOWING FISCAL YEAR

- HOW MANY MONTHS OF FORWARD FUNDING DO YOU MAINTAIN IN YOUR PERSONAL CHECKING ACCOUNT?

- FLIGHT CENTERS AND MAJOR AGENCY PROGRAMS OPERATE WITH LESS THAN 2 WEEKS OF FORWARD FUNDING INTO THE FOLLOWING FISCAL YEAR

- EXTERNAL AUDIT ORGANIZATIONS CAN'T UNDERSTAND WHY WE ASK FOR FUNDS IN OUR BUDGET REQUEST THAT WE WON'T SPEND IN THE CURRENT FISCAL YEAR.

RECOMMENDATION

- SUBMIT ALL NECESSARY INFORMATION BILLING TO YOUR COLLEGE FINANCE, ACCOUNTING, OR BILLING OFFICES ON A TIMELY BASIS (AT LEAST ONCE PER MONTH).

- INSURE THAT YOUR COLLEGE BILLING OFFICE SUBMITS REQUIRED BILLING INFORMATION TO NASA LEWIS EACH MONTH SO THAT LEWIS MAY PROPERLY REFLECT ACCURATE UP-TO-DATE COSTING ON YOUR HBCU GRANT.

Donald J. Campbell is Director of the National Aeronautics and Space Administration's Lewis Research Center in Cleveland, Ohio. He was appointed to this position by NASA Administrator Daniel Goldin on January 6, 1994.

As Director, Mr. Campbell is responsible for planning, organizing, and directing the activities required to accomplish the missions assigned to the Center. Lewis is engaged in research, technology, and systems development programs in aeronautical propulsion, space propulsion, space power, and space sciences/applications. Campbell is responsible for the day-to-day management of these programs, which involve an annual budget of approximately $1 billion, just under 2800 civil service employees and 2000 support service contractors, and more than 500 specialized research facilities located near Cleveland Hopkins International Airport and at Plum Brook Station in Sandusky, Ohio.

Campbell earned a bachelor's degree in mechanical engineering from Ohio Northern University, a master's degree in mechanical engineering and did predoctoral work at Ohio State University. He completed the Senior Executive Seminar in Management at Carnegie Mellon School of Urban and Public Affairs and the Federal Executive Institute Executive Leadership program. He also completed several senior management courses at Brookings Institute.

Campbell began his government career in 1960 as a test engineer for gas turbine engines and engine components in the Air Force Aero Propulsion Laboratory, Wright-Patterson Air Force Base, Ohio. He then worked as a project engineer and later as a program manager for advanced airbreathing propulsion systems.

From February to July 1986, Campbell was assigned as an interim Directorate Chief during the implementation of the National Aerospace Plane (NASP) Program Office, Wright-Patterson Air Force Base. He was Acting Director of the NASP Technology Maturation Directorate. In 1987, he became Acting Deputy Director of the Aero Propulsion Laboratory. In 1988, he was selected for the rank of Senior Executive Service and was appointed Deputy Program Director for the Propulsion System Program Office, Aeronautical Systems Division. He was the senior civilian executive for development and acquisition of new and derivative gas turbine engines for operational aircraft. In 1990, he was appointed Director of the Aero Propulsion and Power Laboratory. He was responsible for the Air Force propulsion and power research and development in the areas of gas turbine engines, ramjet engines, aerospace power systems, and fuels and lubricants.

In 1992, he was named Director of Science and Technology, Office of the Assistant Secretary of the Air Force for Acquisition, Washington, DC In this capacity he monitored the Air Force Science and Technology program and other selected research, development, technology, and engineering programs.

Campbell and his wife, Helen, have four children.

Dr. Michael J. Salkind
President, Ohio Aerospace Institute

Michael Salkind was appointed President of the Ohio Aerospace Institute in January 1990. OAI is a consortium of nine Ohio universities, private industry, NASA Lewis Research Center in Cleveland, and Wright-Patterson Air Force Base in Dayton. Its mission is to facilitate collaboration among industry, universities, and federal laboratories to enhance Ohio and U.S. economic competitiveness through research, education, and technology adaptation.

Before his appointment, Dr. Salkind served as Director of Aerospace Sciences, Air Force Office of Scientific Research, in Washington DC for 10 years. He was Chief of Structures at NASA Headquarters in Washington, DC from 1976 to 1980. From 1964 to 1975, he was with United Technologies Corporation as Chief of Advanced Metallurgy in their corporate research lab and then Chief of Structures and Materials at the Sikorsky Aircraft Division. He received his bachelor's and doctoral degrees in Materials Engineering from Rensselaer Polytechnic Institute in Troy, New York.

A fellow of the American Association for the Advancement of Science and an evaluator for the Accreditation Board for Engineering and Technology, he has published more than 40 articles and a book entitled Applications of Composite Materials.

He has also served on the adjunct faculty of The Johns Hopkins University, University of Maryland, and Trinity College in Hartford, Connecticut.

Dr. Julian M. Earls

Dr. Julian M. Earls, Deputy Director for Operations, NASA Lewis Research Center, is a native of Portsmouth, Virginia, and has been referred to as a "Renaissance Man." He is a scholar who has earned the Bachelor's Degree, with distinction, in Physics from Norfolk State University; the Master's Degree in Radiation Physics from the University of Rochester School of Medicine; and the Doctorate Degree in Radiation Physics from the University of Michigan. He also earned the equivalent of a second Master's Degree in Environmental Health from the University of Michigan and is a graduate of the Harvard Business School's prestigious Program for Management Development.

He is an author who has numerous publications, both technical and educational. He is a teacher and has been Distinguished Honors Visitng Professor at numerous universities throughout the Nation. He is an adjunct faculty member at Capital University, Columbus, Ohio, and has taught at Cuyahoga Community College in Cleveland, Ohio.

Dr. Earls is a humanitarian who has been honored for his community service. He is co-founder of an organization whose members make personal contributions in an effort to raise a million dollars for scholarships to black students who attend black colleges. He has served on the Visiting Committee and the Board of Overseers at Case Western Reserve University and the Board of Trustees at Cuyahoga Community College. Because of his unselfish dedication and service, Dr. Earls was inducted into the inaugural class of the National Black College Alumni Hall of Fame. He was inducted with such distinguished individuals as Dr. Martin Luther King, Jr., and Justice Thurgood Marshall. He holds life memberships in the NAACP, Kappa Alpha Psi Fraternity, and is a Charter Member of the National Urban League.

He is an athlete who has run over 10,000 miles in the past five years. He has entered and successfully completed over 12 marathons, including the Boston Marathon. Dr. Earls is a much sought after orator and lecturer, and has been honored as keynote speaker at the Government House in the U.S. Virgin Islands.

Dr. Earls is a husband and father and is married to the former Zenobia Gregory of Norfolk, Virginia, a Reading Specialist in the Cleveland School System. They have two sons. Julian, Jr., is a graduate of Howard University, and Case Western Reserve University Medical School. Gregory is a graduate of Norfolk State University and is also a graduate of the American Film Institute in Hollywood, California.

Dr. Sunil Dutta

Dr. Sunil Dutta is Program Manager for Small Disadvantaged Businesses (SDBs) at the National Aeronautics and Space Administration's Lewis Research Center, Cleveland, Ohio. Appointed to this position in 1992, he is responsible for implementing policies that ensure the Small Disadvantaged Businesses (SDBs) and Historically Black Colleges and Universities (HBCUs) are encouraged and afforded an equitable opportunity to compete for NASA contracts and research grants. The goal is to increase R&D contracts with SDBs and research grants with HBCUs at Lewis Research Center. Dr. Dutta was honored and received NASA's Exceptional Achievement Medal Award in the area of Program Support. Before assuming the present position, his career has been devoted to research and development of materials science and technology, particularly in the area of process and fabrication research, characterization and mechanical behavior of advanced high performance ceramics and ceramics matrix composites for high temperature structural applications such as heat engines, high speed civil transport and other energy conversion hardwares. Also, he monitored numerous R&D contracts and grants for more than 10 years as project/program manager.

Dr. Dutta joined NASA Lewis Research Center in 1976 after 8 years at the U.S. Army Technology Laboratory, Watertown, Massachusetts. Born in India, he received his B.Sc (Hons), and M.S. from Calcutta University, and M.S. and Ph.D. from the University of Sheffield, England. He also received an MBA degree from Babson College, Wellesley, Massachusetts.

Dr. Dutta has written more than 50 publications including 4 patents and 5 chapters in books.

He is a Fellow of the American Ceramic Society and the Institute of Ceramics in England. He is listed in American Men and Women in Science, Who's Who in Engineering, and Who's Who in the United States.

Dr. Dutta was invited to Japan for one year as Nippon Steel Endowed Chair Visiting Full Professor, at the University of Tokyo's Research Center for Advanced Science & Technology. Since 1987, he visited Germany, Japan, Korea, Singapore, Australia, and India to present invited technical papers/lectures. Dr. Dutta received the Ishikawa Foundation Carbon, Science, and Technology Award for his outstanding international contribution to basic and industrial research in the area of advanced ceramics and composites and for the presentation and diffusion of advanced technology to Japan. Also, actively consulted for industry and government including the CSIR (Council of Scientific and Industrial Research) laboratories in India.

He has actively participated in Local School PTA programs, as Vice-president of Canterbury Homeowners Association, as President of India Association in Boston, Massachusetts, and in Cleveland, Ohio; and co-convener of 5th biennial National Convention of All Asian-Indians in North America.

Dr. Dutta and his wife Kabita reside in Westlake, Ohio. They have three children.

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The purpose of this Historically Black Colleges and Universities (HBCUs) Research Conference was to provide an opportunity for principal investigators and their students to present research progress reports. The abstracts included in this report indicate the range and quality of research topics such as aeropropulsion, space propulsion, space power, fluid dynamics, designs, structures and materials being funded through grants from Lewis Research Center to HBCUs. The conference generated extensive networking between students, principal investigators, Lewis technical monitors, and other Lewis researchers.

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